A Proposed Guideline with Building Information Modelling (BIM) for Virtual Transformation of Traditional Housing to Green Housing

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***Abstract*— Generally speaking, in search of alternative ways that is meant to prevent environment pollution and its sub hazard consequences, developers and planners as well as the masses nowadays are encouraged to use what is call a green home when building their houses. These types of houses typically use resources that are environmentally responsive. However, this new approach to house developments lacks clearly defined and globally accepted standards on what constitutes a green model. Thus, this research aims to educate the public about sustainable transformations from traditional homes to green homes by modelling the 3D model virtually to illustrate the differences between the conventional homes and green homes and its impact on the environment, and demonstrate the types of green alternatives available in Malaysia in order to construct the green homes. The ultimate goal is to create digitally a 3D model of the green homes through Building Information Modelling (BIM). BIM allows the public to run computer simulations that help to understand and visualise the evolutions of the traditional homes to green homes. The digital 3D model is effective in influencing and educating the residents about the benefits of green housing practices and ways to incorporate green building technologies.**

***Keywords*—** *Green Homes, Virtual Modelling, Building Information Modelling (BIM), Education*

1. Introduction

There has been a call to netizens to ‘go green’ by activists in the environment protection arena. For proof of why such a call is more important now more than ever, look no further, a recent typhoon hit the Philippines as well as a continuation of earthquakes that astounded Indonesia are but some reasons “going green” now more than ever matters the most especially if we are to ensure sustainability of life on earth [1]. In order to standardize green homes a certification known as Green Building index was introduced in Malaysia. This certification initiative aims to provide developers with a blueprint on designing and constructing green homes that are energy sufficient, saves water and provide a healthier indoor environment as well as the adoption of recycling.

The idea behind green home is to provide buildings that are as ecologically friendly as possible, this in essence means that green homes is all about making the environment healthier by reducing harmful substances to the environment. According to [2], back to reality, we are in 2018 where the main concern of Building Information Modelling (BIM) is now related to style, status and effect on pollution of using some materials. Consequently, they opted to use the green home concept whereby the houses or buildings are designed with environment and sustainability in mind.

However, the concept of green home was used in Malaysia for the first time in 2007 in Taman Tun Dr Ismail (TTDI), Ampang Selangor [3]. This shows a positive sign in the sense that Malaysians are starting to see the importance of contributing their parts to protect the environment from global warming. Through the assistance of BIM of a green house, Malaysians should be able to gain some knowledge on how to protect the environment by adopting green home concepts in their own homes. Local developers have already begun implementation of green schemes in their construction. In addition, the roles of BIM on improving the awareness are analysed to ensure the

needs are aligned with the current directions and initiatives of this research.

2. Barriers to Green Home Development

A building that implements a variety of the holistic techniques can meet a green building standards. One of the techniques is location. Green homes maximize the resources offered by a home's surroundings, without harming them, and they also take advantage of the local climate. For instance, if practicable, green homes are oriented to face the south to maximize solar heat gain. Next is the materials used. The physical materials used to construct a home are locally sourced, biodegradable, non-toxic, repurposed, and/or renewable. Energy consumption is also one of the techniques. Green homes use energy-efficient appliances and strategic insulation/ventilation methods to reduce artificial heating and cooling [4].

Though the green home building sector is gradually increasing in Malaysia, it is still not famous among the Malaysian because there is a significant challenge of education and understanding. The main challenge faced by developers in Malaysia is the homeowners [3]. Homeowners acceptance level in terms of green homes is not that high due to the fact that it is a new concept and thus lack of understanding or rather they are not convinced yet of the potential benefits of green homes despite the promotional campaigns by the government as well as developers as early as the 2007. Moreover, due to reasons mentioned above, the demand for green home consequently has not been that high as homeowners still prefer to use conventional homes due to their affordability. The demand-supply relationship has been kept that way largely due to the homeowner's unwillingness to pay more for green homes compared to conventional homes, a scenario that has led to the poor performance of green homes.

Another thorny issue in this affordability debacle is that of the developers, keeping to standards of Green Building Index (GBI) in building such homes is seen as an expensive adventure. However, [5] argued that, contrary to developer's view-point green building actually cuts on the day to day operational cost by 9% in addition to increasing the market value of the building by 7.5% as well as return on investment with a 6.6%. With a paradigm shift of the mind coupled with increased educational campaigns about the benefits of green homes, migration to this new concept could be realized.

Other barriers to green homes development have been identified through critical review analysis. A study carried out in Malaysia by [6] indicated the barriers as fear of investment, deficiency in credit funds for start-up cost as well as high costs and reduced demands.

As mentioned by [3], in contrast with other countries the adoption of green tech in Malaysia has proved to be hard to get by despite efforts by the government in promotional campaigns, [7] additionally added that green tech is non-existent here and if this tech is to be imported from across the borders, it will merely translate in additional costs on such housing projects.

Besides, it has been mentioned that the lack of locally assembled skilled personnel in green technology contributed as an obstacle [8] [9]. Demand in green homes from the local people is actually very low and lack of understanding in Malaysia itself [5]. Due to the infancy of green homes in Malaysia local customers lack understanding of the potential benefits of adopting green concepts and its subsequent adoption [3]. Therefore, consequently conventional homes are seen to remain the people's choice of housing for some time to come. A study by [10], indicated that despite cost of green homes, certain company stakeholders are determined to implement it anyways. Sending workers abroad to acquire skills and knowledge on green concepts will benefit the country greatly when it comes to building and maintaining green homes [3].

In addition, low incentives available for builders is identified as one of the barriers, [8] also added in support that the government incentives have not been effective in encouraging developers to adopt these concepts due to the exorbitant prices involved. As a result, additional financial incentives are required to drive local developers in rapid adoption of these concepts. Lack in sustainable buildings awareness could be classed into two groups namely the construction players and the public [10]. Lack of understanding in the green home concepts and its benefits will result in developer's/builders unwillingness to adopt and use

these concepts in the construction of their buildings, additionally, lack of knowledge by the general public essentially result in them opting to buy conventional homes instead of green homes [3]. By having more awareness about green housing, the public would be able to appreciate this concept and apply it to our lives. The public awareness could be done through digital dissemination where this research aims to create and develop a virtual 3D model of green homes through Building Information Modelling (BIM).

3. Building Information of Green Houses

Green building concept is concerned with the prevention of substances that are toxic to the environment through the optimal use of natural resources for development. This means that the green building utilizes considerably low amounts of artificial energy and one that causes the least damage to the environment. A great number of people find that going green has resulted in a reduced carbon footprint and this has resulted in them assisting the environment in staying healthy. Green buildings are designed in such a manner so as to reduce the general impact on the environment and extended to the human health through handling (a) Material efficiency, (b) Water efficiency and (c) Energy efficiency.

Material efficiency is defined as using materials that are environmental friendly as possible, this goes to say materials that are less synthetic, recyclable as well as non-pollutant. Raw materials as it is known is the basic buildings blocks for any housing construction, however, using too much of this raw materials could pose a serious threat to our environment which evidently leads to global warming. Adding on to this premise was [10]. It was stated that to keep up with sustainable development, resources is one of the key element to consider.

Water efficiency is defined as no wastage of water where the rainwater and grey water can be recyclable to use them for toilet flushing for instance. Given that Malaysia receives on average high rainfall annually, this should not create the illusion that there's abundant supply of water [12]. Consequently, in the hope of reducing water use structures such as low-flow water apparatus could be initiated when building green homes. Alternatively, installation of a water management system could be taken up as this approach could conserve fresh water say for human consumption and opt to use greywater for instance to irrigate plants [11].

Energy efficiency is defined as using energy savvy appliances and dependable on all renewable energy resources such as electricity to help improving the indoor air quality. Green building theorizes that there is reduced burden on the environment when developing buildings as well as an increased level of energy efficiency [13]. For now, green buildings are to supply concrete information for individuals in terms of energy saving. For example, installing solar panels in green homes for its renewable energy. Being efficient in material, water and energy supplies, the green buildings can stretch its capacity of local infrastructure greatly.

3.2 Materials Efficiency

Material efficiency deals with allowing for the least use of materials while retaining the quality of finished product as well as aiming to produce small amounts of waste as far as possible. Figure 1 shows the material efficiency samples namely bamboo, stone, low e-glass, non-VOC (Volatile Organic Compounds) paints and wooden.

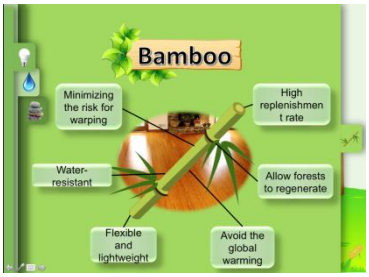


Figure 1 (a). Bamboo

Figure 1 (b). Stone

Figure 1 (c). Low E-Glass

Figure 1 (d). Non-VOC Paints

Figure 1 (e). Wooden

The bamboo is utilized because it minimizes the risk for warping, water-resistant, flexible and lightweight, avoid the global warming, allows forests to regenerate and has high replenishment rate. The stone is used mainly in the kitchen and bathroom. Besides the stone can eliminate the energy, water and other resources, recyclable, durable, no harmful chemicals and it is a natural material with different characteristics. The low e-glass has the functionalities of minimizing the amount of ultraviolet and infrared light, gives good air ventilation, maintaining the indoor temperature and able to radiate energy. As VOC paints are dangerous to health, lime with low percentage of VOC or milk-paint are used for green houses. Non-VOC paints provide deep colour to the wood and allow the grain to show through. The wooden that is well suited for green housing is for instance, treated lumbar and that can be protected from humidity damages. All these are the material efficiency samples are a needed to make a house green.

3.3 Water Efficiency

Water efficiency encompasses the use of water resources in ways that are water savvy so as to ensure that there's water for future generations that they will get to enjoy. To this effect, the use of green buildings allows for such a water saving goal to be achieved by using options such as collection and storage of rainwater, reduced wastage of water by installing efficient plumbing fixtures that helps reduce tension on shared water through the process of water purification as well as recycling. Figure 2 shows the water efficiency through the water-conserving irrigation system.

Figure 2. Water-conserving irrigation system

A good water-conserving irrigation system can reduce lot size, has low water use for landscaping, water efficiency system for indoor fixtures and low flush water system for the toilet use.

3.4 Energy Efficiency

Green buildings designers aim to cut down reliability on non-renewable energy such as coal, they achieve such a goal through the installation of solar panels to capitalize on the sun energy, additionally they also construct windows in such a manner that so as to allow as much natural light possible which in turn reduces the reliance on artificial light. The benefits that comes from saving energy are two-fold, not only do they benefit the users but also the environment around us, in essence the whole world due to the cost factor

involved in non-renewable energy and for the mere fact that they usually cause environmental pollution. Optimizing energy will not only decrease the use of natural resources but will also decrease our electric bills. Figure 3 shows the energy efficiency of the solar panel and LED light used for green houses.

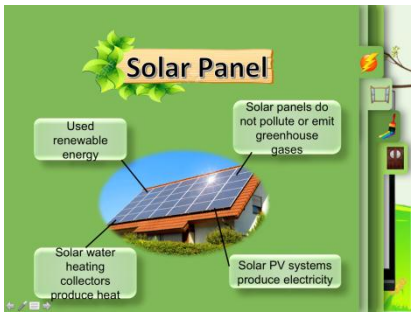


Figure 3 (a). Solar Panel

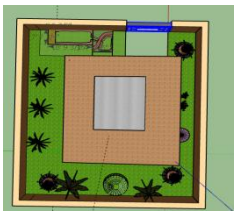
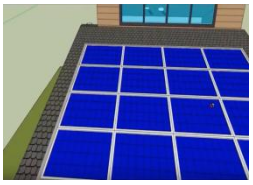
Figure 3 (b). LED Light

On one hand, the solar panels use renewable energy while the solar water heating the collectors to produce heat. Besides, solar panels do not pollute or emit greenhouse gases and solar PV systems produce electricity. On the other hand, the LED light lasts longer, produces less heat and power and low in cost. Using solar panels and LED lights make a greenhouse more sustainable.

4. Modelling of Green Houses

In this paper, we present some 3D model of the green homes that are digitally created through Sketchup Make 2017 based on Building Information Modelling (BIM) collected. There are eight different greenhouses being modelled based on the BIM as shown in Table 1 (a) to (j). To reduce the usage of electricity, daylighting could be implemented, this is the light that penetrates the interior of the house through the windows as well openings in the house. This lighting provides various advantages for the green home owner such as its ability to provide heat in cold days as well cool during hot days.

Table 1. Green House Modelling

 (a) Site and location: Well connected to a larger area closed to amenities and exposed to more sunlight	 (b) Plants in the garden could be irrigated through rainwater
 (c) Color building must be light.	 (d) Water tank: To gather rain water for flushing the toilets.
 (e)Extraordinary energy efficient: Dual windowpane and draft sealer for better humidity.	 (f) Insulation: Better resistant to fire, earthquake, and wind and it is more comfortable to stay in.
 (g) Flooring best uses bamboo, corkwood, hardwood or stone and not concrete, laminated wood or tile.	 (h) Solar photovoltaic/ solar power.
 (i) Structure of the buildings is made of straw bale, stone, timber frame	 (j) Environmentally friendly materials (wood, stone, glass, bamboo, clay brick, ceramic).

Design in daylighting could help to improve optimum use of solar energy in a green home. Daylighting is more so suitable in Malaysia because the country is blessed with sunlight exposure all year long due to its location along the equator line. To increase the amount of daylight penetration inside the interior of the house, glass doors and windows are used in the design of green homes. What is important to note is the location of the windows, they should be placed in such a spot that allows for optimal sunlight penetration as well as for ventilation. The use of light tube has also been adopted in green homes as it helps to reflect daylight and spread it across the house. For instance, green home at Bird Island used light tube because it has lesser heat transfer compared to skylight. Silicon glass was used in the design of this green home due to its lightness as well as flexibility as it is able to sway along with the breeze allowing the homeowner to take a glimpse of the sky whenever the breeze is swayed by the wind.

Solar energy is the most widely used form of green energy in Malaysia, evidently this is due to the prevalent sunshine usually experienced all year round throughout the country. Solar roof shingles are installed to generate solar energy for green home. Solar thermal system captures and stores the heat obtained from the sun and being turn into heat. Backup boiler is used to generate heat on cloudy day. By using solar energy, the homeowner can save electricity cost at Bird Island. A video of our green houses are modeled with its BIM is available at https://www.youtube.com/watch?v=sijOBpqjUS4&feature=youtu.be.

5. Conclusions and Recommendations

The public needs to be educated with the most effective sources so that they can understand the importance of eco-friendly lifestyle and steps to the preservative Malaysia through green housing. Thus, with the aid of 3D digital models and its BIM of green houses, the public is made aware with the approaches towards the environmental issues and instills green housing as part of the lifestyle among the Malaysians.

Despite being exposed to solutions to curb the environmental issues, the public is encouraged to adopt and practice environmentally friendly behaviors.

This study found that there is consideration about 'Green Culture' lifestyle should place a lot of focus on public acceptability and best approach to represent information by using the latest technology. It is recommended that green homes development agencies in Malaysia should increase campaign, involving public so that public awareness about the importance living a greener lifestyle could be enhanced and made popular. Thus, manufacturing sector also should be concerned about the usage of unsustainable resources and rather promote the use of materials and resources that are environmental friendly at a reasonable price. Government of Malaysia should also encourage the concept of "Green Malaysia" and thus organizing a lot of interesting and informative campaign for the public in order to ensure our country adopts green lifestyle that in the long run helps keep our environment pollution free. At the same time, consumers should adopt a shift in paradigm that looks into the long term impacts of buying and practicing green living lifestyle as a much preferred alternative to the current trend that causes destructions to the environment locally and climate change globally.

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